The energy intensity target in China's 11th Five-Year Plan period - Local implementation and achievements in Shanxi Province

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Abstract

Facing the mounting pressure on energy security and increasing environmental concerns about air pollution and climate change, the Chinese government set a mandatory goal of 20% reduction of energy intensity in its 11th Five-Year Plan period (FYP, 2006-2010). In this paper we use Shanxi province to illustrate how policies and measures are implemented in practice at a provincial level as a response to the National FYP issued by the central government. Local policies are described and their effects are analyzed. We compare reported energy saving achievements with our own estimates and conclude that the achievements in Shanxi probably have been substantial since the start of the 11th FYP period. The most important measures taken by provincial and local governments seem to be in the secondary sector, such as Top-200/Top-1000 program and phasing out outdated technologies. However, Shanxi has still a long way to go to achieve satisfactory energy use. Further improvement of energy intensity will require continuing efforts. Although many measures are necessary, improving the energy efficiency in heavy industries and reducing the dependence on these industries should be particularly effective.

Key words: China; Energy intensity; Energy Policy;

1. Introduction

Since 1978, China has experienced rapid industrialization and a transition from a centrally planned economy toward a market-oriented economy that is increasingly more integrated in the world. The average gross domestic product (GDP) growth rate was 10% per year from 1978 to 2008 and China alone accounted for nearly three-quarters of global primary energy consumption growth in 2008. The rapid growth has brought China's primary energy consumption up to a level comparable to the so far largest consumer in the world, USA (BP, 2010). High primary energy consumption has imposed increasing pressure on natural resources. According to BP (2010), China's proven reserves of coal at the end of 2009 were 14% of the world total, that of oil and gas only 1%. There are additional reserves in oil shale, oil sand and coal-bed methane, but the amounts and potential are uncertain. China's increasing dependence on imports of oil, coal, iron ore and other key commodities has been well-documented in international media. In 2009, 52% of China's oil demand was supplied by imports (US-EIA, 2010). According to the Reference Scenario prediction of World Energy Outlook 2009 (IEA, 2009), China will overtake the United States soon after 2025 to become the world's biggest spender on oil and gas imports (in monetary terms). Energy security is challenged by the increasing demands of energy combined with low energy efficiency and insufficient domestic reserves of fossil fuels.

Coal consumption has accounted for about 70% of China's total primary energy consumption since 1978. The energy structure dominated by coal has resulted in great impacts and pressures on the environment, which have caused considerable international and domestic concerns (Gan, 1998; Economy, 2007; Vennemo et al, 2009). The World Energy Outlook

(IEA, 2009) predicts in its Reference Scenario, that three-quarters of the increase of the energy-related CO_2 emission in the period from 2007 to 2030 will come from China.

Facing the mounting pressure on energy security and increasing environmental concerns, the Chinese government has initiated many efforts to promote energy conservation and energy efficiency, and to control the environmental problems. Since the early 1980s, a series of national plans, policies and laws have been enacted. At the very beginning of the 1980s the Chinese central government announced that it would lay equal emphasis on development of energy supplies and energy conservation, with the latter assuming a higher priority in the short term (Sinton et al, 1998). Thanks to many governmental regulations and financial incentives[i] (addressing energy efficiency, energy saving, energy structure and technology development), and to some extent because of the technological improvements inherent in a growing economy, China was able to limit energy demand growth to less than half of the GDP growth from 1980 to 2001 (Levine et al., 2009). Recently, a new so called "scientific development" concept was proposed to achieve a harmonious society and a balanced relationship between humans and nature (Fu et al., 2007). In August, 2008, the National Energy Administration (NEA) was formally established, replacing the Energy Bureau under the National Development and Reform Commission (NDRC), which was established in 2003. Lately (in January, 2010), the National Energy Commission (NEC), a high-level discussion and coordination body headed by premier Wen Jiabao, replaced National Energy Leading Group which was established in 2005, implying that higher priority should be given to energy saving. This is also reflected in China's development goals. In the 11th FYP for Economic and Social Development (NDRC, 2006), mandatory goals for energy saving for the 2006-2010 period are stated. Energy consumption per unit of GDP should decline by 20 percent by 2010 compared with that of the end of the 10th FYP period (2005).

However, the plan was widely considered to be too ambitious, considering that energy consumption had grown more rapidly than GDP in the period 2001-2005 (Lin et al., 2008). Furthermore, China's 10th FYP had also set goals for environmental protection (in the main plan) and energy intensity (in the Special Energy Development Plan of the 10th FYP), but they were not achieved (MEP, 2007). There was general agreement that it would be impossible to achieve the new goals without the strong involvement of provincial and local governments. The problem was how local authorities would contribute, considering that, in China, environmental efforts have lacked effectiveness, resulting in an implementation gap, and that the biggest obstacles to environmental policy implementation are at the local level (OECD, 2006).

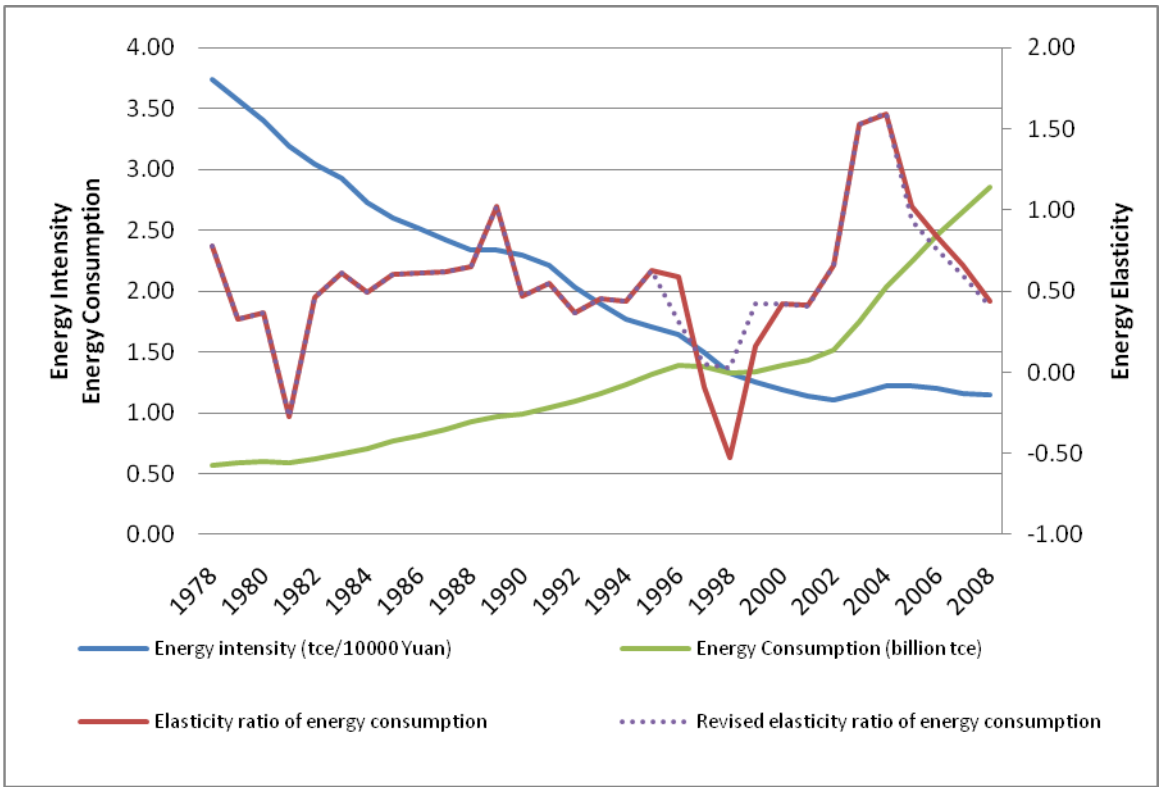
In this paper we use Shanxi province as a case to illustrate how provincial governments attempt to reach the 11th FYP energy saving goal set by central government. We particularly look at local policies aimed at contributing to the national goals on energy intensity. The paper describes energy conservation prior to and in the 11th FYP period in Shanxi. It describes the major policies and policy changes that seem to have been instrumental to the increased success of the 11th FYP as compared to previous FYPs. Achievements are compared to national results, the latter briefly described in Section 5.1. A later paper will describe efforts and achievements in environmental protection.

2. Energy conservation prior to 11th FYP in China

2.1. The national energy conservation

From the initiation of 'reforming and opening' in 1978 to 2002 energy use in China grew at a much lower rate than GDP, with average rates of growth of 4.2% and 9.7% for energy use and GDP respectively. The energy intensity of China's GDP fell continuously until 2001 and the elasticity of energy use with respect to GDP was less than 0.5 on average over the period (see

Fig. 1). However, since China's entry into the World Trade Organization in 2001 energy use has grown very rapidly - over the four years 2002-05 total energy consumption grew by 49% (14% per annum), with GDP growth of 10.5% per annum. Some argue that the apparent excessive growth in energy consumption may partly be linked to energy consumption and production being underreported in the five years prior to 2002 (Sinton and Fridley, 2000; Sinton, 2001; Sinton and Fridley, 2002; Vennemo et al, 2009). In 1998 there was a major change in the statistical coverage as compared with 1997. Before 1998, China's statistical data on industrial sub-sectors covered enterprises with independent accounting systems at or above township level, but since 1998 data covers industrial enterprises above a certain size (see details in Zhao et al. (2010)). Meanwhile, a campaign to close small mines for safety, economic, and environmental reasons began in 1998. Reportedly, 23,000 small mines were closed by May 1999 (Sinton and Fridley, 2000). However, there were indications that many closed mines reopened in secret and that substantial coal use disappeared from official statistics (Sinton and Fridley, 2002). *China Energy Statistical Yearbook 2010* (NBS, 2011a) revised the total energy consumption data for 1998 and 1999 in *China Energy Statistical Yearbook 1997-1999* (NBS, 2000) by an additional 40 and 104 million tonnes, respectively. See the dotted line in Fig. 1 for revised elasticity ratio of energy consumption. The revision confirms the suspected previous under-reporting, and demonstrates that China's energy statistics should be treated with cautiousness.



Note: Energy intensity is measured in terms of units of energy use (tonnes of coal equivalent--tce) per unit of GDP (in 10,000 Yuan in 2005 values).

Fig. 1. Energy consumption, energy intensity and energy elasticity of GDP in China, 1978-2008. Source: NBS, 2011a; NBS, 2000; NBS, 2006-2009.

This rapid growth in energy use was in sharp contrast with earlier trends. The goal of a 15-17% reduction of energy intensity from 2000 to 2005 of China's 10th Five Year Special Plan on Energy Development (NDRC, 2001) was not met. On the contrary, the energy intensity of production slightly increased from 1.47 to 1.49 tce per 10,000 RMB GDP (2000 prices). According to World Bank (2008a) and BP (2010), China's energy intensity in 2005 on a PPP basis was 1.5 times higher than that of the world average, 1.6 to 2.6 times that in developed countries such as USA, Japan, Germany, UK and France, and 1.9 and 2.3 times higher than in India and Brazil, respectively (see Fig. 2).

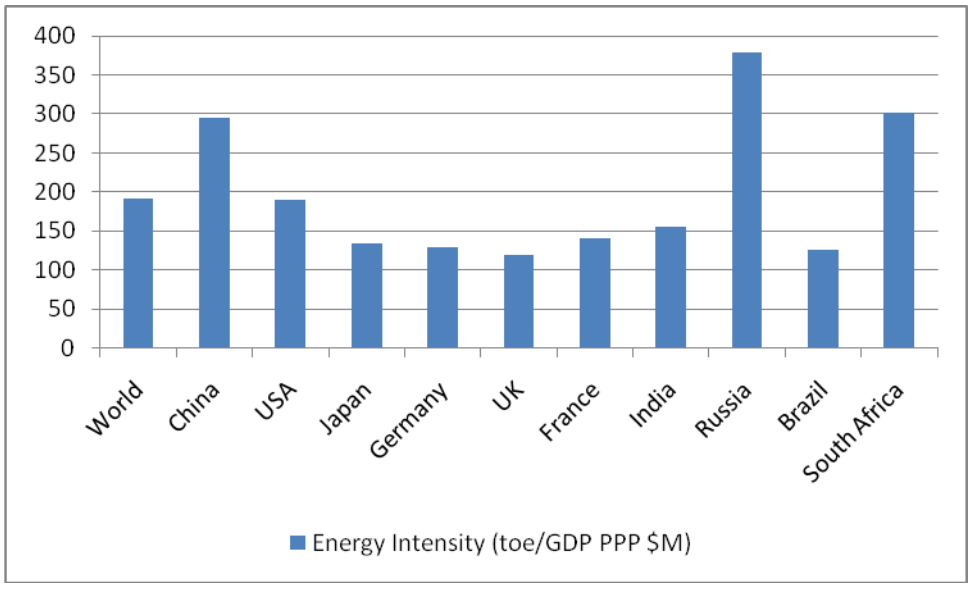


Fig. 2. Comparison of major countries' energy intensity in 2005. Sources: World Bank (2008a) and BP (2010).

The shift in growth rates of energy use after 2001 had profound and unexpected implications for energy markets, and led to severe shortages in 2003 and subsequent years (Sheehan and Sun, 2007; Andrews-Speed, 2009; Zhou, et al., 2009; Levine, et al., 2009; Lin, 2006). If China's energy needs continue to rise rapidly, it could affect the country's energy security, and could become a threat for the local and global environment. Therefore the Government set ambitious targets regarding energy efficiency for the 11th Five Year Plan: over the period 2006-10, energy intensity of the economy should be reduced by 20 percent (from 1.28 to 1.02 tce/10,000 RMB GDP, in 2005 prices), or some four percent per year. This is the first time that a quantitative *and* binding target has been set for energy efficiency, and signals a shift in China's strategic thinking about its long-term economic and energy development. The 20% energy-intensity target also translates into an annual reduction of over 1.5 billion tonnes of CO_2 by 2010 compared to business as usual, making the Chinese effort one of the most significant carbon mitigation efforts in the world today if the country succeeds in reaching the target.

2.2. Shanxi provincial energy conservation

Shanxi Province, located in northern China, with a population of about 34 million, is the most important coal base of the country. In 2005, the base year of 11th FYP, Shanxi produced 554 million tonnes (Mt) of coal, which is about one fourth of the national total; 129 billion kWh of electricity, 5% of the national total; and 80 Mt of coke, more than one third of the national total (NBS, 2011b; SBS, 2011).

Similar to the national trend, the energy intensity of Shanxi's regional domestic product (RDP) fell continuously in the period from 1990 to 2000 with an annual average improvement of 6%. The elasticity of energy use with respect to RDP was less than 0.3 on average over the period (see Fig. 3). The average growth rates of energy use and RDP were 3.6% and 10.2%, respectively. Shanxi's energy statistics probably has a similar problem as the national data. However, the national revisions for Shanxi in 1997-1999 are not available and thus not indicated in the figure.

Since 2001 also in Shanxi energy use has grown very rapidly. Over the 10th FYP period (2001-05) total energy consumption grew by 12.8% per annum, while RDP grew by 14.1% per annum. Especially in 2001 and 2002 the growth was high, when energy consumption grew by 18.3% and 17.2% and RDP grew by 10.1 and 12.9%, respectively. In 2005, its energy intensity of RDP was 3.01 tce/10,000 RMB, which was 2.4 times higher than the national average and the fourth highest among the provinces.

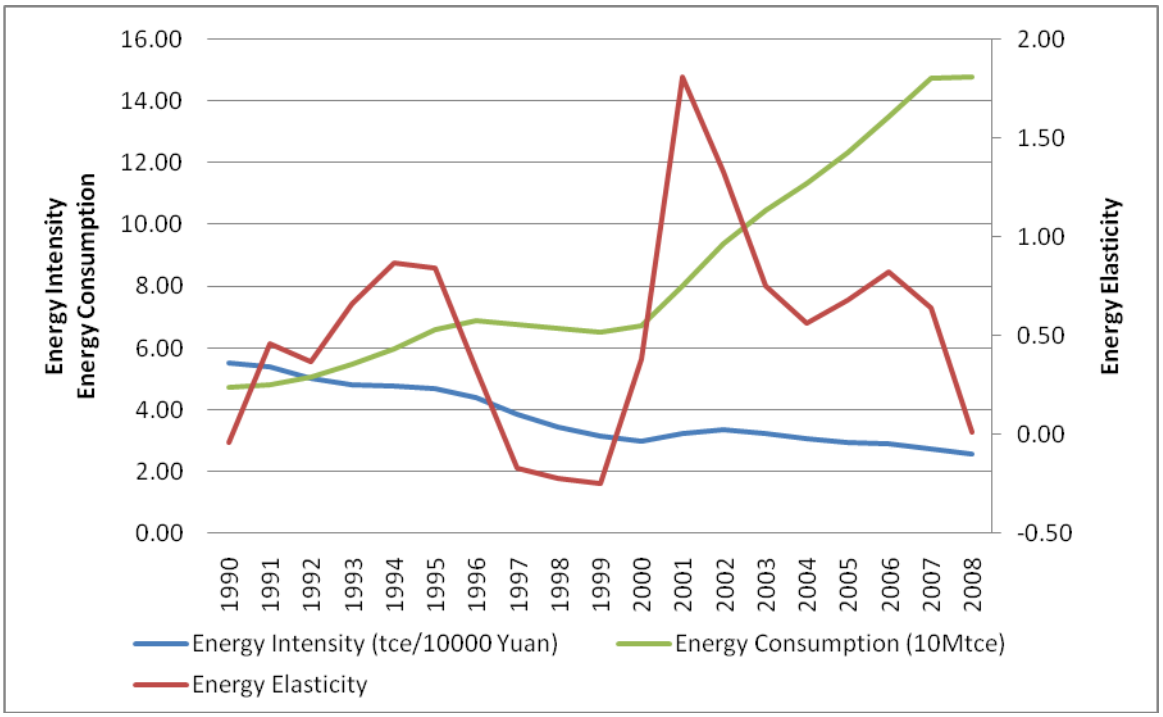


Fig. 3. Energy consumption (million tonnes of coal equivalent--Mtce), energy intensity and energy elasticity of RDP, Shanxi, 1990-2008. Source: NBS, 2011b; SBS (2011).

Shanxi's low energy efficiency is linked to the very high share of heavy industry. Energy consumption in its six largest industries, i.e., coal, chemical, coke, building material, metallurgical, and electricity, takes up 82% of the total energy consumption in the province, and its energy intensity of industrial added value was as high as 4.98 tce/10,000 RMB, which was 2.3 times the national average and the second highest among the provinces in 2005. The rapid growth and the low efficiency of energy consumption pose great pressure on the environment. During the 10th FYP period, Shanxi was the most polluted province and home to the 3 most polluted cities in China for three consecutive years (2003-2005) according to the ranking of the air pollution index of 113 key cities under national surveillance of environmental protection (MEP, 2003-2005).

3. Energy intensity target for Shanxi in the 11th FYP

In late 2006, the State Council approved a scheme disaggregating the 11th FYP's national energy-saving target into energy-saving targets for each province[ii]. While 20 provinces proposed and were given a 20% energy-saving target, seven provinces were given targets ranging from 12% (for Hainan and Tibet) to 17% and four provinces were given targets above 20% (World Bank, 2008b). Shanxi's initial target was 25%, but the target was adjusted to 22% which was proposed by Shanxi government and adopted by the 9th meeting of the standing committee of the 11th Shanxi People's Congress on 26th March, 2009.

4. Policies and measures in Shanxi for reaching the energy intensity target in the 11th FYP period

4.1. Disaggregating targets and planning

4.1.1. The Shanxi Provincial Government Decision on strengthening energy conservation

On 1st Nov., 2006, the Provincial Government approved a scheme disaggregating the 11th FYP's provincial energy-saving target into targets for each city in its *Decision on strengthening energy conservation* (*the Decision*, hereinafter) (see Figure Appendix A). Targets for each year and for the total period are given in Table 1.

Table 1

Energy intensity reduction during 11th FYP period in Shanxi and for important cities

	2006		2007		2008		2009		2010		11th FYP	
	Target	Achieved	Target	Achieved	Target	Achieved	Target	Achieved	Target	Achieved	Target	Achieved
Shanxi [a]	5.8%	2.0%	5.7%	4.5%	5.6%	7.4%	5.5%	5.7%	5.3%		25%	18.3%
Taiyuan	8.3%	2.6%	7.1%	6.0%	6.6%	8.9%	6.4%	6.7%	6.1%		30%	22.3%
Datong	6.4%	3.2%	6.3%	5.8%	6.2%	9.4%	6.0%	7.1%	5.5%		27%	23.1%
Yangquan	5.6%	2.6%	5.5%	4.5%	5.3%	7.2%	5.0%	8.6%	5.0%		25%	21.1%
Changzhi	5.6%	1.7%	5.7%	6.0%	5.7%	8.9%	5.6%	8.1%	5.5%		25%	22.6%
Jincheng	5.8%	1.2%	5.7%	6.5%	5.6%	5.6%	5.5%	5.7%	5.3%		25%	17.8%

Shuozhou	5.6%	0.4%	5.6%	6.4%	5.6%	7.9%	5.6%	6.0%	5.6%		25%	19.3%
Xinzhou	5.8%	2.1%	5.8%	5.4%	5.0%	9.3%	4.4%	7.4%	4.0%		25%	22.2%
Jinzhong	5.6%	1.8%	5.6%	6.5%	5.6%	8.5%	5.6%	7.1%	5.6%		25%	22.0%
Linfen	5.6%	2.3%	5.6%	4.5%	5.6%	6.3%	5.6%	5.6%	5.6%		25%	17.5%
Yuncheng	5.8%	-2.2%	5.5%	4.4%	5.6%	8.4%	5.7%	9.2%	5.5%		25%	18.8%
Lüliang	4.3%	2.5%	4.3%	4.5%	4.4%	7.2%	4.4%	5.6%	4.4%		20%	18.4%

Note: [a]: New disaggregating scheme after adjustment of the target of 25% reduction to 22% is not available; [b]: Aggregated rate for the first four years.

The provincial energy-saving target was disaggregated into sectors. Secondary industry was given a target of 27%, which is estimated to account for about 90% of the total saving. The target for tertiary industry was set to 20%, residential sector 15%, and primary industry 15%, which account for 5%, 4% and 1% of the total energy-saving, respectively (see Table 2).

Table 2

Disaggregating scheme of provincial energy-saving targets for sectors

				11th FYP		2006	2007	2008	2009	2010
				Target	Share[a]	Target	Target	Target	Target	Target
Whole Province				**25%**	**100%**	5.8%	5.7%	5.6%	5.5%	5.3%
	Primary Industry			**15%**	**1.0%**	3.2%	3.2%	3.2%	3.2%	3.2%
	Secondary Industry			**27%**	**89.7%**	6.3%	6.2%	6.1%	6.0%	5.9%
		Industry		28%	89.1%	6.6%	6.5%	6.4%	6.3%	6.0%
			Coal	25%	11.3%	2.0%	5.1%	5.4%	6.8%	8.5%
			Metallurgy	26%	30.9%	6.1%	5.8%	6.1%	6.1%	6.1%
			Power	20%	9.7%	4.4%	4.4%	4.4%	4.3%	4.3%
			Coke	32%	11.3%	8.2%	8.5%	7.9%	6.5%	6.0%
			Chemical	28%	11.5%	8.0%	7.0%	6.0%	4.0%	3.0%
			Building Material	25%	7.0%	2.0%	3.0%	5.0%	8.8%	9.0%
		Construction	New	≥ 50%[b]	--					
			Existing	≥ 30%[c]	--					
	Tertiary			**20%**	**5.0%**	4.4%	4.4%	4.4%	4.3%	4.3%
		Transportation		20%	3.5%	4.4%	4.4%	4.4%	4.3%	4.3%

		Commercial Sector	15%	0.8%	3.2%	3.2%	3.2%	3.2%	3.2%
		Government Dept.	15%	0.8%	3.2%	3.2%	3.2%	3.2%	3.2%
	Residential sector		**15%**	**4.2%**	3.2%	3.2%	3.2%	3.2%	3.2%

Note: [a]: This column gives the share of the total reduction target; [b]: 50% energy reduction for new building compared to the energy use in buildings built in the 1980's; [c]: energy conservation retrofit for more than 30% existing buildings based on the new code of 50% energy reduction compared to the energy use in buildings built in the 1980's.

Based on the disaggregating schemes, the Provincial Government required local governments to disaggregate the cities' targets to counties and major energy consuming enterprises.

In order to realize the targets, *the Decision* calls for implementing "Twelve-Key Projects" which are based on the "Ten-Key Projects" described in the national 11th Five-Year Plan. The "Twelve-Key Projects" are focused on reducing energy use in industry, buildings, and transportation, and are described in Appendix C.

4.1.2. Shanxi Provincial Government Work Plan for energy conservation

In 2006, the energy intensity of RDP in Shanxi was reduced by only 2.0% compared to that of 2005, which was far below the annual target of 5.8%. The slow improvement would make it hard to reach the overall goal of 25% reduction in the following 4 years. To follow up the State Council Comprehensive Work Plan for Energy Conservation, the Provincial Government issued a *Comprehensive Work Plan for Energy Conservation* (the *Work Plan*) in September 2007, as a detailed implementation scheme of the *Decision*. In the *Work Plan* the energy intensity target for the 2007 – 2010 was recalculated to 23.5% reduction (from 2.89 to 2.21 tce/10,000 RMB RDP) saving 51.7 Mtce compared to the baseline, assuming RDP growth rate of 12%. The annual reduction targets were recalculated to: 5.6% for 2007, 6.6% for 2008, 7.0% for 2009 and 7.1% for 2010 (compare Table 1).

In order to reach the targets, a series of specific measures to reduce energy intensity were detailed in the *Work Plan*. These measures include:

- Phasing out industrial production with high energy intensity, high pollution and backward technology. Total energy saving should amount to 12 Mtce;
- Strengthening the management and supervision of the Top-200 Program saving 16 Mtce from 2007 to 2010 through the Program;
- Promoting more energy-efficient and environmental friendly industries, and increasing the contribution of tertiary sector enterprises to the total RDP from 36.4% in 2006 to 39.5% in 2010 saving 5 Mtce from the structure adjustment;
- Promoting the implementation of Twelve Key Projects, saving 12 Mtce;
- Implementing the national taxation and fiscal policies, including differentiated pricing policies for high energy-consuming industry;
- Clarify responsibility and strengthening the management of energy conservation, including: establishing and improving the energy-saving target system, monitoring system and evaluation system, implementing the responsibility system and establishing an accountability system for energy conservation;
- Stepping up information campaigns to raise people's awareness of energy conservation;
- Government should take the lead and play an exemplary role in energy conservation.

4.2. Implementation of energy saving measures in Shanxi

The actions taken in Shanxi to help reach the energy saving target mainly fall into four categories: enhancing energy management, economic restructuring, technical renovation and transformation, and supplementary policies. They will be illustrated separately in the following, while, in fact, they are closely integrated when implemented.

4.2.1. Institutional developments to enhance energy management

In order to successfully organize energy saving in Shanxi, the Shanxi Energy Saving Work Leading Group (the *Leading Group*), headed by the provincial governor and constituted by 13 relevant provincial government departments, was established in 2006 (this was done according to a requirement of *the Decision)*. The *Leading Group* is responsible for overall organization and supervision of energy saving at all levels in Shanxi, including issuing annual energy saving targets for governments at all levels, annual energy intensity targets for different sectors and evaluating energy saving performances of local governments and enterprises. The *Leading Group*'s office, which is responsible for detailed organization and implementation of energy saving, was set in Shanxi Commission of Economy and Information Technology (SCEIT). Similar leading groups have also been established at both city and county levels.

Meanwhile, the Shanxi Energy Saving Supervision General Team (the *General Team*) was established directly under SCEIT in August 2007. Authorized by SCEIT, the General Team is responsible for enforcement of the Energy Saving Law and regulations. To do this the General Team carries out regular monitoring and evaluation of energy use and energy efficiency of key equipments and processes; supervise that obsolete facilities are being phased out according to requirements; and undertakes energy saving assessment and verification of investment projects. Corresponding Energy Saving Supervision Branch Teams have been established at city levels during the 11^{th} FYP period.

Energy management groups have also been established in Top 200/Top 1000 enterprises as required. These groups undertake internal energy use planning, auditing, and reporting, organize internal conservation training and awareness activities, conduct efficient technology development and dissemination, and carry out internal conservation rewarding and punishing.

4.2.2. Economic restructuring

Shanxi's economic structure is dominated by secondary industry. In 2005 it accounted for 51% of the Regional Domestic Product (RDP) (in which the ratio of heavy and light industry share was 15:1), while the tertiary industries accounted for 37%. To improve energy efficiency in the long run, a change in the economic structure was deemed necessary. During the 11th FYP period, Shanxi conducted economic restructuring by phasing out outdated production processes, especially in six most energy consuming industries mentioned in section 2.2, strengthening the approval requirement of energy efficiency on newly built fixed assets investment projects, developing circular economy and promoting development of the tertiary industry.

Economic restructuring is a long term project and might not have immediate effect on energy efficiency, especially when it comes to restructuring through new project approval control, circular economy development and tertiary industry fostering, even though Shanxi has issued a series of policies in these respects. On the other hand, phasing out obsolete production capacities may bring quick impact on energy efficiency. To reach annual targets, Shanxi punished enterprises which did not phase out their outdated capacities within due time by the "Five Stops", i.e. cutting off power supply, water supply, coal supply, transportation services and loan grant. For those phased out before due time, compensation funds were awarded according to the relevant management method described in section 4.2.4.1.2. Reportedly, by the end of September, 2010, Shanxi had phased out obsolete production capacities of 53 million tonnes steel and iron making, 4438 MW electricity generation, 33 million tonnes coke making, 26 million tonnes cement production, 1.42 million tonnes calcium carbide production, and 394,000 tonnes pulp and paper production.

4.2.3. Technical renovation and transformation

According to the calling of the Decision and the Work Plan, technical renovation and transformation in the purpose of energy saving were conducted in all sectors in Shanxi. In the industrial sector, Shanxi conducted the *Top-200/Top-1000 Energy Consuming Enterprises Program (Top-200/Top-1000 Program)* to promote technical renovation and transformation for energy saving, which will be illustrated in detail in the following part. Efforts in other sectors have been described in both the *Decision* mentioned in section 4.1.1. and Appendix D.

Top-200/Top-1000 Program

The Top-200 Program was designed to improve the energy efficiency in the industrial sector. It targets Shanxi's 200 highest energy-consuming enterprises (among them, 86 were already included in the National Top-1,000 Program), which accounts for almost 80% of total industrial-sector energy consumption and 65% of total energy consumption in Shanxi. The industries included in the Top-200 Program are large-scale enterprises in 6 major energy-consuming industries (listed in section 2.2), that each consumed a minimum of 100,000 tce in 2005.

The main objectives are, mainly through technical renovation and transformation, to improve the Top-200 enterprises' energy efficiency; reduce the unit energy consumption of all major products to provincial best practice levels; have the unit energy consumption in some enterprises attain either national best practice levels or sector best practice levels; improve the energy efficiency of each sector; and achieve a total energy saving of approximately 18 million tonnes of coal equivalents (Mtce) in the 11^{th} FYP period. This target has been broken down to the city level.

The Top-200 enterprises are required to set up internal management groups as described above in section 4.2.1. Local governments are to guide and supervise the performance of these enterprises. The Shanxi Bureau of Statistics is to collect and publish information on their

website, and the State-owned Assets Supervision and Administration Commission uses energy saving as a measure of enterprise performance. These data are used in the Appraisal program for government officials and leaders in state-owned enterprises described in section 4.2.4.1.1. All participating enterprises have signed energy-conservation responsibility agreements committing themselves to reaching energy-savings targets by 2010.

From 2009 Shanxi expanded the Top-200 Program to Top-1000 Program which covers all enterprises with annual energy consumption above 10,000 tce. The energy consumption of Top-1000 enterprises accounts for 76.5% of that of the whole province and 89.3% of the energy consumption in the industrial sector. The program adds another 1200 energy conservation projects with about 60 billion RMB of investment and an estimated 11Mtce saving in to the savings expected from the Top-200 program.

4.2.4. Supplementary policies

4.2.4.1. Incentive policies

In order to achieve the energy saving target, a series of incentive policies have been adopted in Shanxi, including the new appraisal and reward programs and financial incentives.

4.2.4.1.1. The appraisal and reward programs in Shanxi

Appraisal and reward programs have proved important for emphasizing the leadership responsibilities of local government officials at all levels as well as of enterprises.

Appraisal Program for Regional Economic and Social Development during the 11th FYP period in Shanxi

The central government called for implementation of the *Scientific Concept of Development* and for a new appraisal system for major leaders of local governments regarding their regional economic and social development to replace the old one which was based on

economic indicators only. Therefore the Shanxi Provincial People's Government approved *The Appraisal Program for Regional Economic and Social Development during the 11th FYP period in Shanxi* (the *Appraisal Program*) in August, 2006. The Provincial Government has revised the Program two times since then. The appraisal of local performance is carried out once a year.

According to the latest revision (December, 2008), the *Appraisal Program* includes 39 indicators belonging to 3 categories: Structural Optimization and Economic Development, People's Livelihood and Social Development, and Ecological Construction and Sustainable Development. In contrast to the previous five-year plans, in which Ecological Construction and Sustainable Development indicators did not count in the appraisal programs, 31% weight is given to this category in the *Appraisal Program* of the 11th FYP. The Program sets energy intensity and emission reduction, which are included in the Ecological Construction and Sustainable Development category, as mandatory indicators. This means that if local governments fail to meet their annual targets for any of these two indicators, they will fail their annual appraisal. In order to assess and evaluate the performance of relevant officials of the local government at all levels and leaders of enterprises in achieving these two mandatory targets, Shanxi provincial government in 2008 issued two quantitative assessment schemes. These are denoted *Shanxi Method of-Evaluation of the Response to the Energy Conservation Target* and *Shanxi Method of Evaluation of the Response to the Pollution Reduction Target*. The first is described below.

Shanxi Method of Evaluation of the Response to the Energy Conservation Target

This quantitative assessment scheme was issued in June 2008 and prescribes the method to be used to assess the energy conservation performance of local governments and Top-200 Program Enterprises (since 2009 this applies to the Top-1000 Program Enterprises) (see

section 4.2.3). The assessment scheme is based on a statistical indicator system and monitoring system for energy intensity of RDP (see Figure Appendix A). A total of one hundred points can be obtained for local governments and enterprises, respectively. Of the one hundred points for assessing local governments, forty relate to two specific annual targets, the compulsory energy intensity reduction target of RDP and the non-compulsory energy intensity reduction target of the regional industrial added value of large industries. The remaining sixty points relate to eight qualitative measures of efforts to enhance the management of energy conservation. Of the one hundred points for assessing Top-200 Enterprises, forty relate to the compulsory total amount of energy saving. The remaining sixty points relate to five qualitative measures of efforts to enhance the management of energy conservation. The reward to governments scoring 95 points or above is 300,000 RMB; 80-95 points give a reward of 200,000 RMB. For enterprises in the Top-200 Enterprises program, 500,000 RMB will be rewarded to the enterprises which scored 95 and above and 200,000RMB to those scoring 80-95. These rewards go to the government/enterprise accounts for efforts to improve energy efficiency. Some of these may be used for personal rewards at city and county levels. Local governments or enterprises that scored below 60 or do not meet their compulsory targets have failed to pass the evaluation. Major officials from local governments and leaders in enterprises that fail to pass the evaluation will not be allowed to participate in the annual provincial personal rewards programs or to be conferred honorary titles. In addition, officials will not be promoted if their jurisdiction fails to meet energy conservation targets. Local governments that fail to pass the evaluation will also be suspended from the jurisdictions' new high-energy consumption projects and from increasing land use for industrial purpose. Similarly, enterprises that fail will be suspended from applying for new high-energy consuming projects and from increasing land use for industrial purpose. Deception in the assessment and evaluation can lead to criminal charges.

4.2.4.1.2. Financial incentives

In addition to a series of national financial policies encouraging energy saving (see Appendix B), Shanxi issued the following financial incentives:

Shanxi Management Method of Special Fund for Energy-saving, issued in May 2008, stipulates that government finance departments at all levels must establish special funds for supporting energy saving, in forms of subsidized loan interest rates, direct subsidies, grants and rewards. The funds shall support energy conservation in industries, the social field, and the construction sector, and establish monitoring and technical service systems and management capacity building for energy conservation. In addition these funds are used to reward cities, enterprises, units and individuals that have achieved outstanding results in energy conservation.

From 2008, 500 million RMB were allocated each year from the provincial government as the *Special Fund for Energy-saving.*

Shanxi Management Method of Special Compensation Fund for Eliminating Backward Production Capacity, issued in May 2008, requires a special compensation fund, raised by the provincial finance department from the Coal Sustainable Development Fund, Power Construction Fund and the provincial budget, for compensating investments in new industry replacing the backward production facilities which are dismantled before the due time set by government. (An extra 10% of the compensation rewards to facilities dismantled one year earlier than the due time, 20% to those dismantled two years earlier, and no compensation to those dismantled later than the due time.) These funds also finance the restoration of landscapes where backward production facilities are dismantled.

By the end of Sep. 2010, Shanxi had allocated 1.31 billion RMB to compensate for the phasing out stated above, and 1.49 billion RMB had been rewarded from the central government.

Differential electricity pricing

With the recover from economic downturn, the production in Shanxi's high energy consuming industries increased very fast. In the first quarter of 2010, average growth rates of production in metallurgy, chemical and equipment manufacturing were more than 40% higher, compared to the same period in 2009. Corresponding figures for coke making and electricity generation were 32% and 23%. Driven by this strong increasing trend, Shanxi's industrial energy consumption increased 31% and electricity intensity of RDP increased 8% compared to the same period in the previous year. In order to curb the unhealthy development, Shanxi further tightened the implementation of the differential electricity pricing policy described in Appendix B3 by increasing the price differential for "restricted" enterprises from 0.05 to 0.1 RMB per kWh and for the "to-be-eliminated" from 0.2 to 0.3 RMB per kWh.

4.2.4.2. Data quality assurance and control

In order to assure and control data quality and avoid local officials fabricating data, Shanxi Provincial People's government approved and issued *The Shanxi Implementation Scheme on Unit GDP Energy Consumption Statistics* and *The Shanxi Implementation Scheme on Unit GDP Energy Consumption Monitoring*, to regulate energy statistics and monitoring in both local governments at different levels and key enterprises. Reported energy saving data from local government and enterprises will be double checked and verified by panels of experts from both provincial and central government level by considering consistency with other indicators, e.g., physical and economic output, freight movements and population, before they

are published by NBS. Any false reporting will be punished according to *Shanxi Method of Evaluation of the Response to the Energy Conservation Target.*

5. Energy saving achievements in the 11th FYP period

5.1. Brief description of national achievements

China's energy intensity of GDP has been decreasing during the first four years of the 11th FYP period, even though the data vary slightly between different sources. According to the statistical communiqués (NBS, 2006-2009), the accumulative decrease over the four year period 2006-2009 was 12.62%. However this was adjusted to 14.65% for the same period, based on the results of 2nd National Economic Survey according to Mr. Jiantang Ma, the general director of NBS (Ma, 2009). The most recent estimate is 15.6%, given by Xie Zhenhua, vice-chairman of the NDRC, in November 2010[iii]. Reaching the 20% reduction target will be hard, considering the latest estimates, as the country will have to reduce the energy intensity with 4.4% in 2010 compared to 2009.

Table 3

Energy saved compared to baseline energy consumption in China (Mtce).

Indicator	**Unit**	**2005**	**2006**	**2007**	**2008**	**2009**
Reported energy consumption	Mtce	2360	2587	2805	2914	3066
Calculated energy intensity	tce/10000 RMB GDP	1.276	1.241	1.179	1.117	1.076
Reproted GDP in 2005 price	billion RMB	18494	20838	23789	26081	28506
Baseline energy intensity	tce/10000 RMB GDP	1.276	1.276	1.276	1.276	1.276
Baseline energy consumption	Mtce	2360	2659	3036	3328	3638
Energy saved	Mtce	0	72	231	414	571

Note: data of reported energy consumption and reported GDP in 2005 price are from NBS, 2011b; energy intensity is derived from both data above.

Compared to baseline energy consumption where we assume a constant energy intensity of GDP since 2005 throughout the 11th FYP period, China has accumulatively saved about 1288 Mtce from 2006 to 2009 (see Levine et al, 2010 and Table 3).

5.2. Energy saving achievements in Shanxi

From 2006 to 2009, the average annual energy consumption growth in Shanxi of 5.3% was much lower than the average RDP growth rate of 10.7%, mainly due to almost no increase in the energy consumption in 2008 (SBS, 2011). The energy intensity of RDP declined from 3.01 tce/10,000 RMB in 2005 to 2.46 in 2009, which is a 18.3% reduction in total and an average annual decline of nearly 4.9%, which ranked no. 6 among the provinces in China and it has reached about 81% to the target of 22% reduction. 7 of 11 cities had reached at least 80% of their 11th FYP targets related to energy intensity by the end of 2009. Based on preliminary estimates, the energy intensity in Shanxi was reduced by 4.24% in the first three quarters of 2010 compared with that of 2009. This is only 0.36% lower than the annual target of 4.6% so it seems likely that Shanxi achieved its 11th FYP target in 2010.

Publicly-available systematic reporting and monitoring of the provincial energy saving programs are lacking. To link the progress in overall energy saving to the different policies and measures described above, we estimate the actual energy saving in individual sectors by using a similar method as was used for the national level above. However, we use the energy intensity for 2005 for each sector in the baseline calculation. As mentioned in section 2.1, revisions of the statistics covering 1996-2008 were recently released. But, Shanxi's data on sectoral shares both in RDP and energy consumption are not available. Calculations of energy saving in primary, secondary and tertiary sectors are based on the revised RDP and total energy consumption data and the unrevised data of the sectoral shares of RDP and energy consumptions given by Shanxi Statistical Yearbooks (see Table 5). The results are shown in

Table 4. Because there is no added value for the residential sector in RDP according to Statistical Yearbooks, we estimated energy saving in this sector using data for reported energy consumption in the residential sector and per capita disposable income for each year, including the baseline year (2005). The rationale is that energy consumption in the residential sector should be closely related to the income level.

Based on the calculation of energy saved by sectors, the improved energy intensity is estimated to have saved about 89 Mtce compared to the baseline energy consumption in the first four years of 11th FYP (see Table 4). Energy saved by secondary industry contributed the lion's share of the total energy saving in the first four years in Shanxi. One reason for the dominating role of the secondary industry is size of the sector and its growing share in the first years, see Table 5.

Table 4

Energy saved by sectors compared to baseline energy consumption in Shanxi. Unit: Mtce

Sector/Year	**2006**	**2007**	**2008**	**2009**	**Sum**
Primary sector	-0.37	0.44	2.60	1.48	4.15
Secondary sector (industry)	6.29	17.34	32.67	27.65	83.95
Secondary sector (construction)	0.01	0.03	-0.21	0.18	0.01
Tertiary sector	0.08	0.51	-1.90	-1.65	-2.96
Residential sector [a]	0.94	2.06	1.24	-0.51	3.73
Total	6.95	20.38	34.4	27.15	88.88

Note: [a]: Residential sector energy saving is calculated from per capita disposable income and per capita energy use in this sector compared to the baseline (2005) values.

Table 5.

Structure of Shanxi's economy (2005-2009) and energy intensities in 2005.

		Sector structure (% of RDP)				
	2005 energy intensity (tce/10000RMB)	**2005**	**2006**	**2007**	**2008**	**2009**
Primary	1.14	6.3 %	5.1 %	4.7 %	7.2 %	6.5%
Secondary industry	4.87	50.7 %	52.7 %	54.8 %	54.3 %	47.8%
Secondary construction	0.35	5.6 %	5.6 %	5.2 %	4.9 %	6.5%
Tertiary	0.40	37.4 %	36.6 %	35.3 %	33.6 %	39.2%
Residential	NA	NA	NA	NA	NA	NA

An alternative way of estimating the total energy saving in Shanxi would be to assume that the overall energy intensity is kept at 3.01tce/10000 RMB, which was the overall energy intensity in Shanxi in 2005, similar to the procedure used at the national level by Levine et al. (2010). We then arrive at an estimated saving in the period 2005-2009 of about 72 Mtce.

Both estimates of energy savings for the period 2005-2009 stated above are much larger than what was reported by the General Office of Shanxi People's Government, 30 Mtce (see Table 6). We assume the reason for the big differences is the baseline they are using, which is not available from present sources. Assuming an annual *baseline* reduction in energy intensity of 2.44% in the period 2005-2009, we arrive at the official figure of 30 Mtce energy saved in Shanxi (instead of the 72 Mtce mentioned above).

Table 6.

Energy savings in Shanxi, 2006-2009 Unit: Mtce

	Reported total energy savings[a]	**Reported energy savings from *Top 200/1000 Program***[b]	**Estimated energy savings from phasing out outdated capacity**[c]	**Estimated energy savings from social field**[d]
2006-2009	30	19	9	2

Source: [a]: SPG, 2010; [b]: SPEIC, 2010, 2009, 2008; [c]: Appendix E; [d]: Derived from the total minus energy savings from other two parts.

In spite of the differences, both our calculation and the reported values show that the lion's share of the energy savings in Shanxi in the period 2006-2009 is due to energy intensity improvements in the industrial sector.

To compare the energy saving in Shanxi with the national saving, the baseline assumptions should be the same. For the period 2006-2009 we therefore choose 72 Mtce, although, as seen from Tables 4 and 6, different choices of baseline may give both higher and lower values. The national savings in this period was 1288 Mtce (see Table 3). The Shanxi contribution is thus nearly 5.6%.

One problem worth to mention is the inconsistency in data revisions for Shanxi. Energy consumption data in Shanxi Statistical Yearbook 2010 (SBS, 2011) have been revised according to the newly revised values in the China Statistical Yearbook 2010 (NBS, 2011b), while its year by year energy consumption growth rates remained unchanged.

5.3. Discussion

Three different estimates of energy saving in Shanxi during the period 2006-2009 are given in this paper. The assumptions about energy intensities in the baseline are crucial for the estimates. In the first estimate we assume a baseline where *the energy intensity in each sector*

is kept constant at the 2005 level throughout the 11th FYP period; in the second we assume a baseline where *the overall energy intensity* is kept constant at 2005 level in Shanxi throughout the 11th FYP period; the third is the officially reported energy saving, presumably obtained assuming a slight reduction in energy intensity during the period. It is subjective which method to choose. The second method would be appropriate if there were no changes in the economic structure. Since this is not the case, we think the first method is more informative, since it takes into account that sectoral shifts actually have taken place (see Table 4).

In spite of the differences between the alternative estimates, the energy saving and energy intensity reduction achievements in Shanxi probably have been substantial in the first four years of the 11th five year planning period. The fact that energy efficiency is very high on the policy agenda of China's governments at all levels, is demonstrated by the variety of policies being implemented. The energy data available indicate that these policies have resulted in substantial improvements in energy intensity.

In Shanxi, the government's decision to focus on those sectors which yield the greatest immediate impact seems to be the main reason for the achievements. Shanxi government focused on the industrial sector through implementing Top-200 Program and phasing out obsolete production capacity, complemented by incentive financial policies. According to reported energy savings, the Top-200 Program contributed 63% of the total energy savings, and according to our estimate (Table E3 in Appendix E) phasing out outdated capacity contributed 30% (Table 6). To achieve this, Shanxi provincial government allocated increasing funds for energy efficiency improvements mainly in this sector, starting at 4 million RMB in 2006 increasing to 900 million in 2008. Funds which reached 260 million RMB for the same purpose were also allocated from municipal governments in 2008. To further improve the progress, in July 2009, Shanxi Energy Conservation Leading Group Office issued "*The Promotion Plan on Major Energy Saving Projects in 2009 and 2010"*

including more than 1000 energy saving projects with total investment of more than 62 billion RMB and a total of 18 Mtce expected energy saving when finished. Through implementing a series of policies and measures, the energy intensity of secondary industy added value in Shanxi declined from 4.98 tce/10,000 RMB in 2005 to 4.07 in 2009, which is 18.3% reduction (NBS, 2011b). In general the energy intensity decreased more in Shanxi than nationally, although from a worse starting point. In 2009, Top-200 program was further expanded to be Top-1000 and estimated to save additional 11 Mtce in the last two years of 11^{th} FYP period. In 2010, further 140 enterprises with outdated technology in non-ferrous industry, steel and iron industry, and cement industry should be phased out.

Meanwhile, steps have also been taken to save energy in the social field, even though the energy consumption in the social field, which includes contribution from several sectors, is only 15% of the total. Through implementation of key projects and actions targeting the population in general, achievements in energy conservation in the social fields were significant and contributed 7% of the total reported achievements according to Table 6. The largest contribution is from residential sector. The potential annual energy saving of 3.9 Mtce is estimated by increasing the use of district heating and removing more than 10,000 smaller coal-fired boilers and thus reducing average heat-supply energy intensity from 90kg/GJ to 40 kg/GJ. Energy saving in buildings and energy saving in villages are also addressed. Further details are given in Appendix F.

Policy implementation is the most important issue. It is of great significance that the energy intensity target in the 11^{th} FYP, as opposed to previous FYPs, is defined as “compulsory”, i.e. it is a mandatory target that the governments at both the central and local levels are responsible for achieving. Also, the fact that achievement of the target is tied to a person’s political career by a personal penalty and reward system for governmental officials seems to be effective. Meanwhile, the economic incentive policies likely have great influence on

energy conservation. In the current paper we are not able to explicitly quantify how individual policies and measures have contributed to energy saving in Shanxi. However, we have used the available sectoral data in combination with information about the implemented policies and measures to suggest what may have been of most importance.

The World Bank Mid-term Evaluation of China's 11th FYP (World Bank, 2008b) attributed the progress achieved so far to several key factors which also apply to Shanxi. These include a high level of political commitment, generally improved administrative capacity to rapidly roll out new initiatives, strong public support for the objectives, the adjusted accountability system that links implementation to performance assessment of local officials, and increased central funding. The policy measures introduced were described as comprehensive and relevant to the objectives.

For further reduction of energy intensity in a long run, we suggest the following issues should be addressed:

(1) Energy intensity of RDP in Shanxi is still high. Even though great efforts have been devoted to improve it, the energy intensity in 2009, 2.46 tce/10,000 RMB GDP, was more than twice the national average, 1.08 tce/10,000 RMB GDP. Clearly there is a need for strengthening the energy intensity goal in the 12^{th} FYP and beyond.

(2) While Shanxi has taken steps to close small, inefficient industrial facilities, industrial structure adjustments towards higher value-adding manufacturing as well as to service industries, have had limited success to date. The share of secondary industry in the provincial economy grew steadily in the period 2005-2007, but has decreased somewhat the two last years (Table 5). The share of tertiary industry, which is less energy intensive, was slightly higher in 2009 than in 2005. However, with the economic recovery, the situation may become worse. According to the newest update of social and economic development in Shanxi in the first quarter of 2010, the added value of secondary industry increased 27.8%, while, primary

and tertiary industries increased only 6.7% and 11.3%, respectively, compared to the same period in 2009.

(3) Compared to an estimated 72 Mtce energy saved in the first four years of 11th FYP using the calculation method where we assume both a constant 2005 energy intensity *and* a constant economic structure as the baseline throughout the period of 11th FYP, we arrive at an additional 17 Mtce energy saved when we take into account the fact that the economic structure in Shanxi has changed. Obviously, an economy based on heavy industry is the main reason for the high energy consumption in Shanxi. It results in high coal consumption, accounting for about 92% of Shanxi's total coal consumption. Thus, further structural adjustment, renewable energy development and a shift to low carbon economy are urgently needed.

(4) With the rapid economic growth and the increasing living standard, energy conservation in the social field is becoming more and more important. More effective policies are needed to encourage a change in behavior amongst the citizens and a more environmental friendly life style.

(5) After a minor economic downturn, China's economy seems to be back on the high speed track. With rapid economic growth, the energy consumption has long been increasing. Consequently, CO_2 emission has been rocketing. Therefore, CO_2 emissions should be limited and carbon intensity should be emphasized.

(6) Penalty and award mechanisms based on the new appraisal system seem to be an important incentive in energy conservation in Shanxi as in other provinces. But, millions in awards are also a temptation to fabricate data. Thus, good monitoring and accounting systems are essential.

6. Conclusions

The achievements in energy saving in Shanxi have been substantial since the start of the 11th five-year plan period. The provincial and local governments have put energy efficiency very high on its policy agenda, and devoted a considerable amount of effort to achieving the goals. Very detailed requirements and regulations have been issued. The most important measures so far seem to be in the industrial sector (not including the construction sector), such as Top-200/Top-1000 program and phasing out outdated technologies. However, Shanxi has still a long way to go to achieve satisfactory energy use and limit its CO_2 emissions. Further improvement of energy intensity will require continuing efforts to optimize the economic structure (in particular reduce the dependence on heavy industry), change the system of public administration, and improve the personnel appraisal system to provide stronger incentives for achieving energy intensity reduction.

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[ii] Targets of 20% reduction or more proposed by provinces were accepted by the central government. For other provinces the target was decided by the central government based on level of economic development, structure, current energy intensity of GDP, total amount of energy consumption, per capita energy consumption and the level of energy self-sufficiency, etc. (State Council, 2006).

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